WHAT IS CLAIMED IS:

1. An ink-jet printing head comprising:

a pressurizing chamber substrate having first and second sides opposing each other;

a plurality of pressurizing chambers formed on the first side of the pressurizing chamber substrate;

channels formed on the second side of the pressuring chamber substrate to be opposite to the pressuring chambers, respectively;

oscillating plate films for pressurizing ink within the respective pressurizing chambers; and

piezoelectric thin-film elements, each having upper and lower electrodes and a piezoelectric film sandwiched between the upper and lower electrodes, the piezoelectric thin-film being formed in the channel,

wherein at least the upper electrode is formed to have a narrower width than that of the pressurizing chamber.

2. The ink-jet printing head according to claim 1, wherein the pressuring chamber substrate is a silicon monocrystalline substrate of (100) orientation,

wall surfaces of side walls which separate the plurality of pressurizing chambers from each other form an obtuse angle with respect to the bottom of the pressurizing chamber; and

the wall surface of the side wall is made of a (111)

plane of the silicon monocrystalline substrate.

3. The ink-jet printing head according to claim 2, wherein wall surfaces of side walls of the channels formed on the second side of the pressuring chamber substrate form an obtuse angle with respect to a bottom of the pressurizing chamber, and the wall surface of the side wall is made of the (111) plane of the silicon monocrystalline substrate.

4. The ink-jet printing head according to claim 1, wherein the pressuring chamber substrate is made of a silicon monocrystalline substrate of (110) orientation; wall surfaces of side walls which separate the plurality of pressurizing chambers from each other form a substantial right angle with respect to a bottom of the pressurizing chamber; and the wall surface of the side wall is made of a (111) plane of the silicon monocrystalline substrate.

5. The ink-jet printing head according to claim 4, wherein wall surfaces of side walls of the channels formed on the second side of the pressuring chamber substrate form a right angle with respect to the bottom of the pressurizing chamber, and the wall surface of the side wall is made of the (111) plane of the silicon monocrystalline substrate.

6. The ink-jet printing head according to claim 4,

wherein wall surfaces of side walls of the channels formed on the second side of the pressuring chamber substrate form an obtuse angle with respect to the bottom of the pressurizing chamber.

7. The ink-jet printing head as defined in any one of claims 1 through 6, wherein the lower electrode serves as the oscillating plate film.

8. A method of manufacturing an ink-jet printing head, comprising the steps of:

forming a plurality of channels in one side of a silicon monocrystalline substrate;

forming an oscillating plate film on the bottom of each channel;

forming a piezoelectric thin-film element which comprises a piezoelectric film sandwiched between upper and lower electrodes, on the oscillating plate film; and

forming pressuring chambers in the opposite side of the silicon monocrystalline substrate so as to be opposite to the channels, respectively.

9. The manufacturing method for the ink-jet printing head according to claim 8, wherein the forming step of the piezoelectric thin-film element comprises the steps of:

forming the lower electrode;

forming the piezoelectric film on the lower electrode;

forming the upper electrode on the piezoelectric film; and

removing a portion of the upper electrode to make an effective width of the upper electrode narrower than an width of the pressurizing chamber.

10. The manufacturing method for the ink-jet printing head according to claim 9, wherein the forming step of the piezoelectric thin-film element comprises the steps of:

forming a piezoelectric film precursor; and

subjecting the piezoelectric film precursor to a heat treatment in an atmosphere including oxygen so as to change the piezoelectric film precursor to the piezoelectric film.

11. The manufacturing method for the ink-jet printing head according to claim 9, wherein the removing step comprises the steps of:

forming a pattern of etching mask material which acts as a mask to an etching substance, in the areas of the upper electrode which are desired to leave; and

etching away the areas of the upper electrode that are not covered with the etching mask material.

Species A etching
" B laser

12. The manufacturing method for the ink-jet printing head according to claim 9, wherein, wherein the removing step of:

removing a portion of the upper electrode by irradiating the areas of the upper electrode desired to remove with using a laser beam.

13. An ink-jet printing head comprising:

a pressurizing chamber substrate;

a plurality of pressurizing chambers formed on one side of the pressurizing chamber substrate; and

a recess formed on one side of the pressurizing chamber substrate so as to leave a peripheral area,

wherein the pressurizing chambers are formed in the thus-formed recess, such that a thickness of the peripheral area of the pressurizing chamber substrate is formed to be greater than a thickness of side walls that separate the plurality of pressurizing chambers from each other.

14. The ink-jet printing head according to claim 13, wherein a nozzle plate is fitted to the recess.

15. The ink-jet printing head according to claim 13, further comprising:

stoppers formed on the side of the pressuring chamber substrate having the pressurizing chambers formed thereon;

and

receiving sections for receiving the stoppers which are formed on the nozzle plate to be bonded to the side having the pressuring chambers formed.

16. The ink-jet printing head according to claim 13, wherein a difference "d" between a thickness of the peripheral area of the pressurizing chamber substrate and a height of a side wall that is a partition between the pressurizing chambers, and a distance "g" from the border between the recess and the peripheral area to the side wall of the pressurizing chamber in the closest proximity to the border, satisfy a relationship $g \geq d$.

17. A method of manufacturing an ink-jet printing head having a plurality of pressurizing chamber substrates formed on a silicon monocrystalline substrate, each pressurizing chamber substrate having a plurality of pressurizing chambers formed on one side thereof, comprising the steps of:

making a recess formation including the steps of,

partitioning the silicon monocrystalline substrate into unit areas to be used in forming the pressurizing chamber substrate, and

forming a recess in the side of the pressurizing chamber substrate in which the pressuring

chambers are to be formed, for each unit area so as to leave a peripheral area along the circumference of the recess; and

making a pressurizing chamber formation including the steps of,

further forming the pressurizing chambers in the recess formed in the recess making step, and

making the thickness of the peripheral area of the pressuring chamber substrate greater than the height of a side wall for separating the pressurizing chambers from each other.

18. A method of manufacturing an ink-jet printing head having a plurality of pressurizing chamber substrates formed on a silicon monocrystalline substrate, each pressurizing chamber substrate having a plurality of pressurizing chambers formed on one side thereof, comprising the steps of:

making a pressurizing chamber including the steps of,

partitioning the silicon monocrystalline substrate into unit areas to be used in forming the pressurizing chamber substrate, and forming pressurizing chambers in the side of the pressurizing chamber substrate in which the pressuring chambers are to be formed, while leaving a peripheral area along the circumference of the unit area; and

making a recess including the steps of,

further forming a recess in the area where the pressurizing chambers are formed in the pressurizing chamber formation step, and

making the thickness of the peripheral area of the pressuring chamber substrate greater than the height of a side wall for separating the pressurizing chambers from each other.

19. A method of manufacturing an ink-jet printing head having a plurality of pressurizing chamber substrates formed on a silicon monocrystalline substrate, each pressurizing chamber substrate having a plurality of pressurizing chambers formed on one side thereof, comprising the steps of:

making a recess including the steps of,

partitioning the silicon monocrystalline substrate into unit areas to be used in forming the pressurizing chamber substrate, and

forming a recess in the side of the pressurizing chamber substrate opposite to the side on which the pressurizing chambers are formed in each unit area, while leaving a peripheral area along the circumference of the unit area, wherein the mechanical strength of the silicon monocrystalline substrate is maintained by increasing the thickness of the pressurizing chamber substrate in the peripheral area than the thickness of the pressurizing

chamber substrate in the recess.

20. The manufacturing method for the ink-jet printing head according to claim 19, wherein the step of making a recess further comprises the steps of:

forming a layer to be processed;

providing the layer to be processed with a resist and patterning the resist;

etching the layer to be processed corresponding to the recess masked in the resist mask formation step;

further etching the area of the silicon monocrystalline substrate from which the layer to be processed has been removed as a result of the etching step; and

forming a layer to be processed in the recess etched in the recess etching step.

21. The manufacturing method for the ink-jet printing head according to claim 19, further comprising the steps of:

forming a piezoelectric thin film sandwiched between electrode layers, in the recess formed in the recess forming step;

forming a resist on the piezoelectric thin-film formed in the piezoelectric thin-film forming step, by a resilient roller;

exposing the silicon monocrystalline substrate having the resist formed thereon in the resist forming step;

developing the silicon monocrystalline substrate exposed in the exposing step;

etching the piezoelectric thin film having the resist formed thereon in the developing step, so as to form a piezoelectric thin-film element; and

forming the pressurizing chambers on the other side of the silicon monocrystalline substrate so as to correspond to the piezoelectric thin-film elements formed in the etching step.

22. The manufacturing method for the ink-jet printing head according to any one of claims 17 through 21, further comprising the step of:

separating the recess that does not include the peripheral area from the silicon monocrystalline substrate so as to individually separate the pressurizing chamber substrates, when the pressurizing chamber substrate is separated from each unit area after the pressurizing chamber substrates have been formed.

23. The manufacturing method for the ink-jet printing head according to any one of claims 17 through 21, further comprising the step of:

separating the pressurizing chamber substrates from

the silicon monocrystalline substrate so as to include the peripheral area, so that the pressurizing chamber substrates are individually separated from each other, when the pressurizing chamber substrate is separated from each unit area after the pressurizing chamber substrates have been formed.